Bring Our Children To Work Day 2006

NASA/Blair JSC2006E24097

NASA /Blair JSC2006E24099

Johnson Space Center welcomed hundreds of kids on its annual Bring Our Children To Work Day in June. This year's theme, "Where We've Been, Where We're Going," focused on NASA's plans to explore the moon, Mars and beyond. Kids got to see where their parents work, learn what they do every day and see exciting presentations about space exploration.

Above, Richard Watson, of JSC's Crew and Thermal Systems Division talks about spacesuit technology.

At right, the children take in a spaceflight presentation.

Space Center Roundup

The Roundup is an official publication of the National Aeronautics and Space Administration, Johnson Space Center, Houston, Texas, and is published by the Public Affairs Office for all Space Center employees. The Roundup office is in Bldg. 2, Rm. 166A. The mail code is AP411. Visit our Web site at: http://www.jsc.nasa.gov/roundup/online/ For distribution questions or to suggest a story idea, please call 281/244-6397 or send an e-mail to jsc-roundup@mail.nasa.gov.

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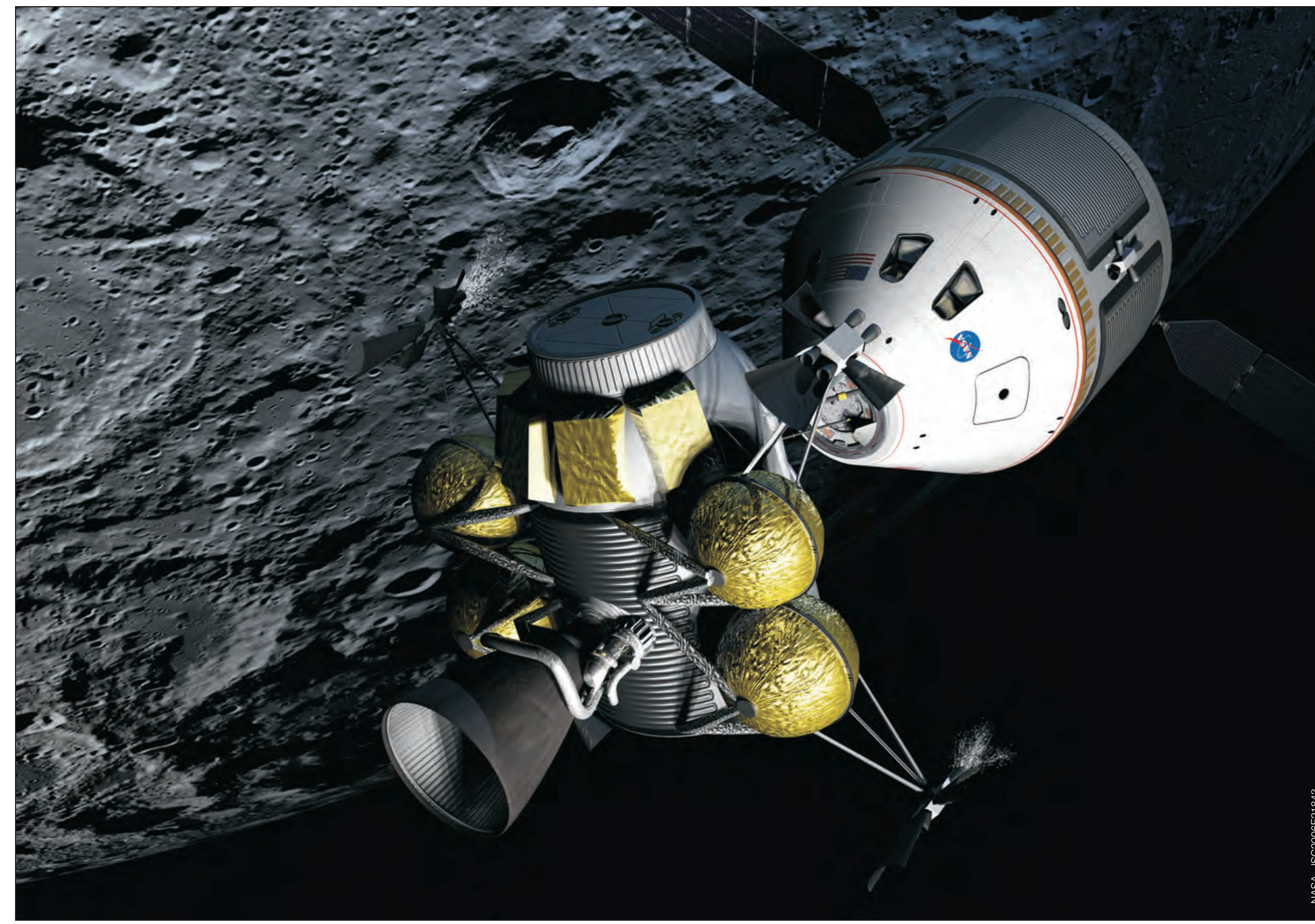
Permit No. 39

National Aeronautics and Space Administration

Lyndon B. Johnson Space Center
SPACE CENTER ROUNDUP
Volume 45 • Number 7
JULY 2006

Roundup



NASA JSC2006E21843

Constellation program

NASA's Constellation Program is getting to work on the new spacecraft that will return humans to the moon and blaze a trail to Mars and beyond. This artist's rendering represents a concept of rendezvous and docking operations between an unmanned crew vehicle and a manned lunar lander.

FROM THE
director

A MESSAGE FROM CENTER DIRECTOR MICHAEL L. COATS

Keeping things in perspective

I write this column a month in advance, so my expectation is that *Discovery* is safely in orbit, we are enjoying the success of the STS-121 mission and recognizing the hard work of the thousands of folks on our Team NASA.

We read a lot about how old the shuttle is, but it will be many decades before we see another spaceship with similar capabilities. Getting back into the business of flying the shuttle on a regular basis is important to each and every one of us, but it is also a symbol of national pride and technological strength.

We have just celebrated America's independence, and I hope everyone has had a terrific Fourth of July holiday! While we are accustomed to thinking of ourselves as a "young" nation, our 230 years of history make us one of the oldest systems of government on Earth. We often get so busy in our daily lives that we forget we live in an amazing time in an amazing country.

The media concentrate on the negative, but the fact is that by almost any measure we live in the best of times. Despite the wars in Iraq and Afghanistan, fewer people were killed in worldwide conflicts last year than at any time in recorded history. We complain about the cost of health care and prescription medicines, but we have the best medical care in the world by far. It is available to more and more people, and our medicines have to be considered "miracle drugs" by any reasonable definition. After years of slow progress, we are now making significant headway in the fight against cancer and may well see cures in our lifetimes. Life expectancy has increased dramatically over the last century. (Our associate director, Randy Gish, not only has grandchildren, but his grandparents are still healthy! Good genes, I'm sure, but in general we can all expect to live longer and healthier lives.)

As engineers we tend to want to fix and "improve" everything, but the challenges we face today are no more serious than at any other time in history, and the quality of life is dramatically better. It's natural to complain, and as Americans we have a First Amendment right and responsibility to do so, but we also need to keep things in perspective. Our nation has much to be proud of, and the space program, which is visible evidence of our passion, spirit and belief in the future, is one of **our** proudest achievements.

I would once again encourage everyone to get more involved with our local community. Despite the heat, humidity and hurricanes, this is a terrific place to live and work because of the people who make up the community. We need to support the local governments, schools, clubs and activities to continue to provide our children with all the amenities we enjoy.

Mike

BED-REST PROJECT STUDIES ARTIFICIAL GRAVITY

Lying down for science

by Bill Jeffs

It's an admirable thing to stand up for one's beliefs. But recently, some brave individuals went a step further by lying down in the name of science.

They were participating in an artificial gravity study led by Johnson Space Center and the Massachusetts Institute of Technology. Weightlessness can have negative effects on the human body—for instance, muscle and bone loss—and artificial gravity may help mitigate those effects. The study was designed to test that theory.

"Artificial gravity has long been limited to the province of fiction writers and artists," said Dr. Bill Paloski, NASA principal scientist in JSC's Human Adaptation and Countermeasures Office.


NASA/Stafford JSC2006E08315

A view of part of a NASA-provided short-radius centrifuge at UTMB in Galveston.

Paloski is the principal investigator for the project, which is conducted at the University of Texas Medical Branch at Galveston and is scheduled to run throughout this year. "This study is our first attempt to scientifically evaluate a practical prescription for its use in space as a multisystem countermeasure," he said.

Volunteers for the study spend three weeks lying down in a bed that is tilted by six degrees so that their heads are lower than their feet. This position simulates the effects of weightlessness on the body, and can result in some of the same health effects after a long period of time.

Some of the volunteers, the "treatment" subjects, take a spin each day on a short-radius centrifuge (SRC) to determine how much protection it provides from bed-rest deconditioning. These subjects are positioned on the centrifuge in the head-down bed-rest position and spun up to a force equal to 2.5 times Earth's gravity—2.5 Gs—for an hour. Then they return to their beds. The "control" subjects also spend an hour each day on the centrifuge, but they are not spun.

The SRC has two "arms," each about 10 feet long. Subjects lie on narrow, bed-like sections. The faster the arms spin about the SRC's pivot point, the higher the Gs created by centrifugal force. An instrumented foot plate measures G-forces at the subject's feet.

The platform that subjects lie on slides back and forth—or up and down, from the subjects' perspective. They can pump their legs, keeping the blood flowing to their head. Test subject Timothy Judd said that the movement was "like a leg press in a weight room."

Judd, the second subject to complete the study, wrapped up his 41-day test run in May. For him, a good part about spending a lot of time in bed was the chance to catch up on watching movies. However, he said he had trouble relying on others for constant assistance.

"What I did find difficult was going from an independent, do-it-yourself mentality to a full dependency on others," he said. For example, Judd said he had to adjust to asking for his toothbrush and having someone else put his socks on.

The spinning centrifuge did not bother him, he said.

"Oddly enough, it is not like spinning at all," said Judd. "The centrifuge operator turns down all the lights, so you lose all points of reference in the room. It feels as if you were standing stationary with a heavy backpack—maybe 50 pounds or so—on your shoulders."

After the study, Judd said his first steps were a little unsteady.

"I felt that I had awakened from hibernation," he said. "My back was a little stiff, and I just felt groggy in the same way you feel when awakening from a deep sleep. When they allowed me to take a couple steps toward the wheelchair, the biggest thing I felt was a loss of confidence in movement."

Paloski said that scientists still have a lot of work to do in studying artificial gravity and its role in future space exploration.

"Because gravity affects many of the body's systems, we may need to look at a number of possible prescriptions before we can settle on one that would be best for future long-duration space travelers," said Paloski, adding that there may be a need for future volunteers for the study.

To find out more about the JSC Human Test Subject Facility, visit **http://www.bedreststudy.com/default.aspx**.

FAILURE ANALYSIS TEAM

Failure *is* an option

JSC group learns how materials break in order to build safer spaceflight hardware

by Catherine E. Borsché

Sherlock Holmes may not be employed at Johnson Space Center, but there are many individuals in JSC's Failure Analysis Team who emulate the famous detective in their everyday jobs.

The Materials and Processes Branch at JSC performs a sort of detective work called failure analysis on aerospace-related parts and hardware. The group analyzes materials for several programs, such as the International Space Station, space shuttle and Crew Exploration Vehicle, as well as facilities such as Ellington Field and the Neutral Buoyancy Laboratory.

The knowledge gained from failure analysis can be used to prevent failures, improve future designs and understand environmental and service effects on material behavior.

In other words, the analyses conducted by the group help ensure the safety of equipment used in space as well as on the ground.

"Our work benefits the space program and exploration because materials troubleshooters make our hardware safer," said Heather Fireman, materials and processes engineer. "As long as we are building structures and machines, there is the potential for problems with the materials composing them. Properly diagnosing the problem and recommending changes to avoid it in the future are key to getting the most out of our advanced materials."

The most accepted approach to failure analysis is the funnel approach. This track starts with an infinite number of possibilities and uses a systematic process of elimination by various test methods to determine the cause of a failure.

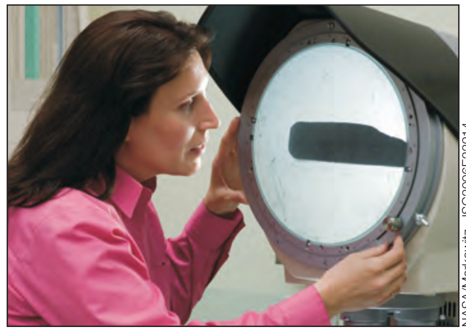
"Our goal is to determine the root cause of the failure (in the structure); that way, we can then provide recommendations for improvement for future processes and materials," Alma Stephanie Tapia, metallurgical and materials engineer, said. To do that, the team goes through a variety of steps during the failure analysis, some of which include identifying the way an item failed, finding the site of the failure and figuring out where the failure started.

In general, the investigation process begins with the most nondestructive techniques and then proceeds to more destructive techniques, gathering data from each test throughout the process. However, each investigation is unique and testing techniques are often selected based on a customer's needs and the shape and size of the material being investigated.

"Basically the first step is usually a visual inspection of the part," Tapia said. "You do measurements to make sure you understand the dimensions of it and take initial pictures so you understand what you're getting."

In addition to visual inspections, the team does testing on the object while it is still intact. Afterwards, methods become more "destructive" to get a better picture of the failure from an internal point of view.

"I do some scanning electron microscopy and some metallic materials microstructural evaluation," said Glenn Morgan, aerospace engineer for the Engineering and Science Contract Group. Morgan said that he utilizes "metallography techniques such as sectioning, mounting, grinding, polishing and etching."



NASA/Markowitz JSC2006E22914

NASA/Markowitz JSC2006E22917

Top photo: ***Leslie Schaschl measures the dimensions of a failed part with an optical comparator.***

Bottom photo: ***Mike Kocurek prepares a compression test.***

For example, "we do cross sections of (a piece of hardware) to look at the microstructure," Tapia said. Using this technique enables the team to "get a close view of what's inside the material."

On the mechanical side, testing can involve cooling, bending, fatiguing and other methods to evaluate the hardness of the object to various stressors.

The team members also use complex equipment to perform their analyses.

"I use a Light Optical Microscope to photographically document the specimen, which is typically a piece of hardware from the space shuttle, space station, Ellington Field aircraft such as a T-38 or institutional support hardware. I also do lots of digital photography to record the 'as-received' condition of the hardware," Morgan said.

It is very important for a failure analyst to remain objective during the testing and not jump to unwarranted conclusions.

"The more failure analysis that you perform, the more reserved a failure analyst is in making conclusions," said John Figert, metallurgical engineer and Failure Analysis Team lead. "Analysis results often are not what you expect, so it is very easy to make the wrong conclusion prematurely. Once you burn yourself once or twice badly, you often learn wisdom."

Tapia echoed the same thought. "You can never know—never assume. Sometimes you can have an idea of what might have caused a failure, thinking, 'It looks like it might be this,' but you have to always go check it out, and you might find something completely different. Occasionally projects that seem like old projects might shed new light on something you've done before," Tapia said. "It's a constant discovery process."

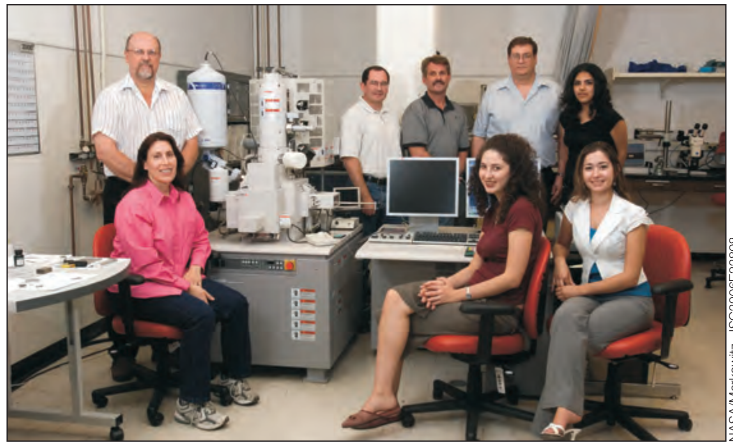
The investigators said they enjoy their detective work, and are invigorated by the challenges they face when it comes to deciphering a unique problem.

"I mostly enjoy learning about the many ways materials can fail, as pessimistic as that sounds!" Fireman said. "We are concerned with real-world problems of materials engineering—the humid, salty air at the Cape (Canaveral) as a corrosion threat, or the tendency for small surface imperfections to raise local stresses and initiate cracks. The challenge is to make materials work in spite of all these things."

Although experts in the field, the team members unearth many unknowns that often make for interesting scientific revelations.

"I am quite frequently surprised by some of the findings. We have the best minds in the world designing and fabricating flight hardware, yet the environment in which we operate is so hostile that we still have some unanticipated results," Morgan said.

As Morgan indicated, the Failure Analysis Team is crucial for the future of exploration as NASA wishes to explore even bigger unknowns in the universe. "(Our) work benefits all the programs in that it allows us to make better decisions in material selection and hardware design in support of fabricating the safest systems for the future of manned spaceflight," he said.



NASA/Markowitz JSC2006E22898

The Failure Analysis Team: back row, from left are Glenn Morgan, Rodrigo Devivar, Mike Kocurek, John Figert and Daila Gonzalez. Front row, from left are Leslie Schaschl, Heather Fireman and Alma Stephanie Tapia. Not pictured: Gordon Fowkes, Louis Hulse and Penny Gardner.

Failure Analysis Team Lead John Figert places a fractured surface under a stereomicroscope.

NASA/Markowitz JSC2006E22907

Quest10ns

Jeff Hanley talks about the Constellation Program

by Kelly Humphries

NASA established the Constellation Program in October 2005 to turn the ideas of the 60-day Exploration Systems Architecture Study (ESAS) into a sustainable human space program. Veteran flight director Jeff Hanley is leading the agencywide team that is meeting the challenges of developing spacecraft for a new generation of explorers.


NASA JSC2006E21444


NASA JSC2006E21447


NASA JSC2006E21448


NASA JSC2006E21449

Cargo launch vehicle concepts

Top photo is an artist's rendering of a cargo launch vehicle blast off, carrying a lunar lander and a "departure stage" needed to leave Earth's orbit.

Next is a concept of solid rocket booster separation following the launch of a cargo launch vehicle, which will carry a lunar lander and a "departure stage."

Cargo launch vehicle illustrated in orbit after releasing the covering for the lunar lander.

This artist's rendering represents a concept of a cargo launch vehicle as the first and second stages separate in Earth orbit.

1 ***What's the status of the Constellation Program today?*** We're right where we ought to be, considering that the program office has only been in existence for a little over six months. I've been focusing my efforts on creating a structure for the program that's based on the successful model of Apollo, establishing our key requirements based on our long-term needs, goals and objectives and identifying where in NASA we have the skills and facilities to make it all happen. The next step is to finish defining the requirements, finalize the designs and start building hardware. Throughout the rest of the process, we will continue component testing that's already begun and get ready for integrated testing of major elements.

2 ***How are you organizing the program?*** We've set up an organization structure that's very similar to what George Mueller and Sam Phillips did on Apollo, but adds an Advanced Projects Office that will spin off additional projects later on. The basic structure includes the following offices.

- The Program Planning and Control Office, led by Barry Waddell, will be the policy and procedures police for the program.
- The Test and Verification Office, led by Bill Arceneaux, will validate all of the development work.
- The Operations Integration Office, led by Bob Castle, will make sure we integrate mission operations through the development, test and flight phases of the program.
- The Systems Engineering and Integration Office, led by Chris Hardcastle, is establishing and documenting all of the requirements for the program.
- The Safety, Reliability and Quality Assurance Office, led by Lauri Hansen, will make sure that everyone at NASA and our contractors stay vigilant when it comes to safety.

Matrixed with these will be the Crew Exploration Vehicle (CEV) Project Office, led by Skip Hatfield at JSC; the Launch Vehicle Project Office, led by Steve Cook at Marshall; the Ground Operations Project Office, led by Tip Talone at Kennedy Space Center; and the Mission Operations Project Office, led by Dennis Webb here at JSC.

The Advanced Projects Office that Carlos Noriega is in charge of will spin off other project offices for landers and other surface support systems.

I also have some key help from my deputy, Mark Geyer, and two associate managers, Tip Talone at KSC and Todd May at Marshall. Deb Neubek is my chief of staff for technical issues, and Brenda Ward is my assistant manager for program integration. Marsha Ivins is my special assistant for technical integration and the lead Astronaut Office representative to the program.

3 ***What does the Constellation architecture look like now?*** We're building on the great work that Mike Griffin and the ESAS team did last spring to put together a plan for an affordable, sustainable fleet of vehicles that can take over soon after the shuttle is retired at the end of the decade. The systems we build need to be as simple and as low-mass as we can make them and be maintainable along the way. Our current designs start off with the CEV, which is an Apollo-like capsule, only bigger, that can carry up to six crew members to the space station or four to the moon.

continued on page 8


NASA/Caplan JSC2006E21990

In a pose reminiscent of a famous photograph from the Apollo era, NASA Exploration managers hold a wind tunnel model of NASA's next spacecraft during a recent tour of Langley Research Center. From left are: NASA Deputy Associate Administrator for Exploration Doug Cooke, CEV Project Manager Skip Hatfield, CLV Project Manager Steve Cook, Langley Exploration and Flight Projects Head John Herrin and Constellation Program Manager Jeff Hanley.

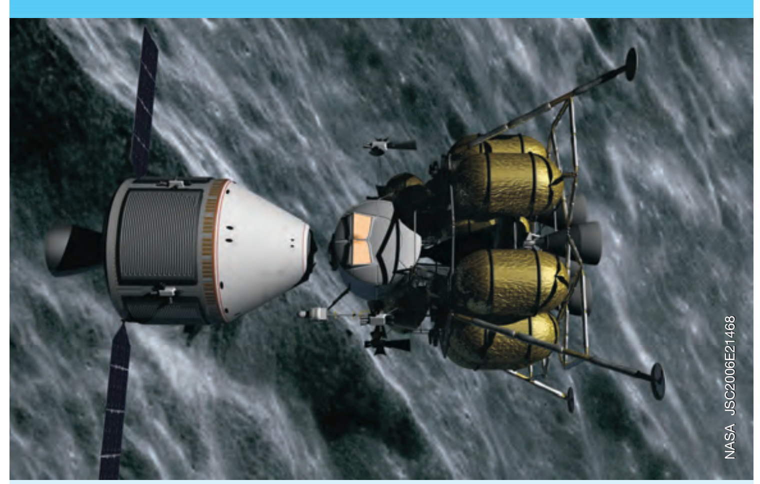
Crew launch and exploration vehicle concepts

Top photo is an artist's rendering representing a concept of the crew launch vehicle on a launch pad.

A concept of rendezvous and docking operations between a crew exploration vehicle (CEV) and a lunar lander and departure stage.

Lunar lander undocks from the CEV while in moon-orbit. The CEV will remain unmanned while the astronauts descend in the lunar lander.

The CEV as it lands on Earth under its recovery parachutes (out of scene).



The Crew Exploration Vehicle actually consists of:

- the crew capsule
- a launch abort system that can rescue the crew at any time during launch
- a service module that contains thrusters for attitude control, an Earth-return engine, propellants and solar power cells
- a spacecraft adapter for connecting it to the Crew Launch Vehicle (CLV)

The adapter will connect the spacecraft to the CLV upper stage, which includes a shuttle-like tank and a modified J-2 engine from the Apollo era. That upper stage is mounted on top of a shuttle-like solid rocket booster with an extra fifth segment.

Instead of sending everything for a moon mission into orbit on one vehicle like Apollo, we'll use two. The second vehicle will be a heavy lifter that carries the Earth Departure Stage and its J-2X engine, the lander and surface support systems into orbit. Two five-segment solid rocket boosters and five RS-68 liquid hydrogen/liquid oxygen engines will power the Cargo Launch Vehicle.

For lunar missions, which we plan to start no later than 2020, the Cargo Launch Vehicle will launch first. Then, the CEV/CLV will launch with the crew. The CEV and service module will rendezvous and dock with the lander and Earth Departure Stage in Earth orbit before beginning the trip to the moon. We're planning shorter, week-long missions to the moon at first, but we're looking at ways to leverage the hardware we put on the surface for longer missions as we build up to a sustained presence on the moon's surface. We'll test the CEV and CLV early in the next decade and then make shakedown mission to the station starting no later than 2014.

The Apollo guys did a lot of work analyzing the safest and most efficient shape for ascent and entry. They decided the Apollo capsule shape was optimal. Since the physics of spaceflight haven't changed in 40 years and the Apollo shape had a proven track record, the ESAS team recommended this same shape over several other possible configurations. More detailed analysis by the Constellation team subsequent to ESAS has further supported the conclusion that even a larger version of the Apollo capsule is still the preferred shape for ascent and entry.

...we're on track to meet or improve upon a first CEV launch with astronauts by 2014, and a first crewed moon mission by 2020...

4 ***What happened to using the space shuttle main engines and liquid oxygen/liquid methane propellant choice proposed in ESAS?***

It's normal for programs to make these kinds of changes in the early stages. The Apollo program made numerous major design changes before settling on the configuration that flew. The original ESAS idea was to make use of current shuttle and legacy Apollo systems to build something that would be 10 times safer that the shuttle. As Constellation has taken a closer look at technical trades, we've seen areas where it made sense to change in order to benefit interoperability and long-term affordability. I'm sure there will be more changes in the months and years ahead as the vehicle designs and mission plans mature. We compared the shuttle engines to other rocket engines available, and came to the conclusion that a modified version of one used in Delta IV rockets would be half as expensive to update and build. As for "green propellants," we haven't ruled them out; we've just decided not to mandate them for early missions because of anticipated development time and cost. We're hoping that our prime contractors will offer a way to build them in at some point.

5 ***When will we fly the first Constellation missions?***

This is a go-as-you-pay program, so that depends on the amount of funding we receive from Congress and the administration. With our current funding profile, we're on track to meet or improve upon a first CEV launch with astronauts by 2014, and a first crewed moon mission by 2020. We are working hard now to make smart decisions on how to apply limited funding so that everything will come together at the right time. We have recently begun planning for our first test flight of the CLV, which might occur as early as April 2009.

6 ***What is JSC's role in the program?***

JSC is hosting the program office, the CEV Project Office and the Mission Operations Project Office. The Constellation Program manages and integrates the program and all projects, just like the Space Shuttle Program does for the shuttle and the International Space Station Program does for the station. The CEV Project manages and integrates all CEV elements, including prime contractor work, in the same way the Orbiter Projects Office manages the orbiters. The Mission Operations Project manages and integrates all activities related to Mission Operations, including flight operations, crew training and the mission control center for human exploration missions. In addition, we're using our formidable in-house expertise at JSC to design the cockpit and to build some key components for the crew vehicle, such as a Low-Impact Docking System for lunar missions and the parachute systems for landing.

7 ***How do the other NASA centers fit in?***

In June, we announced the work assignments being given to the NASA centers. We're going to use all available resources and capabilities to provide a U.S. crew launch capability replacement as soon as possible after the shuttle retires. We're trying to maximize the use of existing facilities and technical expertise across the agency and provide a template for future work assignments. We're trying to synchronize the work around the agency to minimize program costs and mitigate program risk. In a nutshell, each center will contribute as it is best qualified. We're going to continue to refine these plans to keep them consistent with the overall agency budget plan.

8 ***Are you coordinating the transition to the new vehicles with the shuttle and station programs?***

Yes, we are. I'm working closely with Wayne Hale and Mike Suffredini to make sure we don't spend money on the same thing twice and that we have a smooth transition from the shuttle era to the Constellation era. And at the same time, Scott Horowitz and Bill Gerstenmaier are working closely with one another. There are some tricky issues associated with this kind of transition. And all three programs are working on limited budgets. The Constellation Program is not going to immediately start paying for everything we do in human spaceflight. The transition will be a gradual process, with Constellation Program funding ramping up as Space Shuttle Program funding tapers off. But we're talking through these issues and documenting our decisions.

9 ***When will we select a prime contractor for the CEV?***

The source evaluation board is going over the proposals submitted by the two bidders—Lockheed Martin and the Northrop Grumman and Boeing team. We expect to make a final selection in early September.

10 ***What do you see as the biggest challenge facing your team?***

I want to see humanity—see America—go to Mars. So the biggest challenge I see is creating a transportation system that's affordable and sustainable. We have to significantly cut the cost of getting mass into orbit, because every pound we put on the surface of the moon will cost us much more than just getting into Earth orbit. And we have to do it with a budget that is less than 1 percent of the federal budget, not the 4 percent that Apollo had. And we're going to have to keep reminding ourselves that we're setting the table well for the generation that will go to Mars. We need to give them a foundation at least as good—if not better—than the Apollo generation bequeathed to us.

Along for the ride

Tram tours give visitors a glimpse into space program

by Brad Thomas

THROUGHOUT the years, Johnson Space Center has been the site of many historical events, and many more will follow as the Vision for Space Exploration takes off. Since the public has limited access to the center to see the groundbreaking work done here, the best opportunity is through Space Center Houston's tram tour.

Space Center Houston is the official visitor center adjacent to JSC. More than 750,000 people visit Space Center Houston each year, and more than 500,000 of those visitors choose to take the tram tour.

Space Center Houston Operations Manager Anson Brantley said the organization operates at least one tram tour per hour and as many as one every 10 minutes.

"We have the capacity to put 4,800 people a day on the tram tour," Brantley said.

A normal tour lasts 60 to 90 minutes. Brantley said the amount of time and the number of tours depends on the number of stops on the schedule and the number of people wanting to take the tour.

The stops on the tour include the historic Mission Control Center (MCC), the training facilities in Building 9, Rocket Park and the Memorial Tree Grove. Due to mission schedules and other considerations, not all of the stops are available every day.

"Mission Control is always a great building to visit," Brantley said. "We are excited to have the Saturn V Facility open."

Space Center Houston is a popular destination for groups, especially students. A large group of middle-school students from the Lone Star Leadership Academy recently took the tram tour.

It was the second trip to Space Center Houston for Leadership Academy director Christin Siller. She said the tram tour allows people to get a better sense of the current happenings within the space program.

"To be able visit the space center allows you to put things in perspective," Siller said. "You can feel the history."

The tour begins with the tram snaking down a path from Space Center Houston's main building and through a tunnel under Saturn Lane to the grounds of JSC. During this stretch, the tour guide begins to give an oral history of the space center.

Ironically, it is not symbols of technology that first greet the tram riders: They are instead welcomed by a brilliant display of wildflowers and Texas longhorns near Rocket Park.

After passing Rocket Park, the tram heads to its first stop: Building 30. The group enters the building and makes its way up 87 steps to the historic MCC observation room. The room overlooks one of the original Mission Control rooms, which still contains computers from the Apollo days. The audience then listens to a presentation on the history of MCC by one of Space Center Houston's volunteers.

The visitors then reverse course and head back to the tram for the ride to Building 9.

Before going up to the Building 9 observation deck, the group watches a video describing the facility and its activities.

From the observation deck, visitors get an impressive view of mockups of present and future International Space Station components. As the walking tour progresses, they pass by space shuttle mockups before arriving at the area where robotic arm simulations take place. If the timing is right, those on the tour can see engineers working or astronauts training in the facility.

The next stop for the space buffs is in front of the Memorial Tree Grove. It is here that visitors learn about the ultimate sacrifice that some have made in the name of exploration. The riders are given a description of the site and then hear an excerpt of President George W. Bush's speech from the Space Shuttle *Columbia* memorial service in 2003.

Siller said she was moved by this part of the tour. "I think it is a great way to end the program," she said. "It allows you to get a sense of the importance of the (space) program. Listening to President Bush's speech allows you to be proud of the sacrifice."

The next stop for the riders is Rocket Park. Here, visitors are given a choice: stay on the tram and head back to Space Center Houston, or check out the rockets at Rocket Park, including the recently refurbished Saturn V.

Flora Hollifield, an eighth-grade student from Dallas, said she enjoyed the history associated with the tram tour. She singled out historic Mission Control as her favorite stop because of its authentic Apollo-era equipment. "I like the Mission Control room," Hollifield said. "I like that they kept all of the computers."

Space Center Houston and the tram are also a big hit with families. Jimmy and Anna Baker of Santa Fe, Texas, took their grandson Jeremy for a visit. Jeremy said the MCC was the most interesting part of the tour.

His grandfather agreed. "The speaker was really good," he said. "It brought back a lot of memories."

Clockwise from left: ***An employee drives a Space Center Houston tram past JSC's Rocket Park.***

Visitors learn about Building 9's training facilities before heading up to the observation deck.

Even covered in plastic, the Saturn V rocket makes quite an impression. The plastic will remain until all interior work is complete.